Notes by Alexander Graham Bell, July 3, 1901

1901, July 3 Wednesday at 1331 Conn. Ave. THOUGHTS.

“Hot as ever in spots” — “Death and suffering increasing alarmingly” — “Forced closing of factories” — “Hospital facilities are taxed as never before.” Monday's high record all quotations eclipsed at some points in path of the heat wave”.

These are some of the headings in this morning's paper, Post and the reports from the different cities contain as many deaths and prostrations as would be caused by bullets in a great battle.

It would be interesting to add up some of the numbers here:—

PLACE DEATHS PROSTRATIONS TOTAL Philadelphia 52 300 352 Other places in Penn. 5 Wilmington,Del. 9 30+ 39+ Baltimore 13 39 52 Camden, N. J. 2 15 17 New York, N. Y. 148 180 328 Jersey City 8 Pittsburg 50 52 Toledo, Ohio 3 Cleveland 5 18 Cincinnati 2 16 Chicago 3 Kansas City 4 Oscalusa 3 St. Louis 4 7 Richmond, Va. 2 8 Winchester, Va. 1 Norfolk, Va. 1 Wheeling, West Va 4 King George, Va. 1 TOTAL. 313 672 Total 985 2

313 deaths and 672 serious prostrations are incidentally referred ton in the this morning's Washington Post, Wednesday July 3, 1901, as having occurred yesterday. This indicates that throughout the country thousands of people were prostrated yesterday, and there were many hundred deaths.

In some cities the hospitals were obliged to use automobiles omnibus s es as ambulances, on account of the wholesale prostration of the horses. Deaths and prostrations have been reported upon a wholesale scale for more than a week past. and

It is obvious that I was right in the idea that the passage of a heat wave across the continent causes as much death, and probably more suffering, than a great battle.

Horses suffer most of all, because they are obliged to work out of doors. Men and women are prostrated in their own homes and in their places of business. One of Mr Charles Bell's assistants, in the American Security & Trust Company yesterday reeled from his chair and fell, and had to be removed.

That people should die from the effects of heat in their own homes and offices, is as much a reflection upon the inventive capacit ies y of the American people, as though they were to die in their houses from cold. The invention of means of rapid transit, by railroads, steamboats, &c. has stopped invention relating to the cooling of houses. Every man who can afford it simply travels to a cooler place during the hot weather, and those who cannot afford to leave are left to their fate.

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At the passage of every hot wave hundreds die, and infant mortality is enormously increased. We cannot at all measure the mortality and suffering caused by the hot wave by the deaths and prostrations reported , as due to the heat alone. The whole population is enervated by the heat, so that they are less able to withstand ailments of any sort.

The death rate and the sick list jump s up on every hand, children die by the wholesale, and the mortality from every cause is increased during the hot weather; largely because of the enervation of the system, so that the sum total of disaster is probably beyond computation — AND IT IS largely PREV A e NTABLE.

It is true we cannot control the weather outside, but why cannot we control the weather inside of out own houses and offices. What would we say were hundreds of people to be frozen to death in their own houses during every cold snap? Would it not be obvious that the remedy would be in the hands of the people. All they have to do is to warm their houses.

Why is it not equally obvious that where hundreds die in their own houses at every hot wave, that the remedy is the converse of the last — cool the houses.

As we have furnaces in the basement to heat the houses in cold climates, so should we have refrigerating plants in the attics to cool the houses in warm climates. But, as a general rule the houses in warm climates or warm places, are not adapted to refrigeration, and the houses themselves would need to be changed. They are 4 all open below — to allow of circulation of air, and windows and doors are generally thrown wide open so that should cold air be poured into them from above by means of a refrigerating plant, it would leak e out below like water out of a sieve.

You might produce a very Niagara of very cold air rushing down from above, and it would produce comparatively little effect in cooling the house if it escaped below. The houses must be tight below, and the hot air in the lower part of the house be displaced by cool air from above — not necessarily from above. Let it be introduced into the house in any way, and it will displace the hot air, and cool the house — if the house is tight below, but not otherwise.

Introduce cold water into a tumbler of warm water, in any way you like, and the cold water will displace the warm water and drive it out above, so long as the tumbler is tight, but let there be a hole in the bottom of the tumbler, and the cold water will rush out of that hole, and if any water at all remains in the tumbler it will may be warm.

So, the necessity is a house air tight below, and open above, so as to allow of the escape of the hot air from the house. Under these circumstances cold air admitted into the house in any way will displace the warm air in the house, force it up through the top, and keep the whole house cool. The simple admission of cool air anywhere will not only keep the house cool, but keep the air fresh and pure., For the air contaminated by breathing is warmed by the lungs, and would be driven off with the other hot air of the house , — not so sure about CO_2 .

The carbon dioxide however is specifically heavier than ordinary air, and should it be cooled in the house, it might settle down in the lower regions instead of escaping — in which case, if the house were tight below, you might ultimately have a regular death trap there. Don't think there is much in this, however, for CO_2 But the quantity would hardly be sufficient; for Carbonic Acid gas(CO_2) is subject to the usual laws of gaseous diffus s ion, and would tend — however small in quantity — to diffuse through the whole house, and escape at the top, just as if there was no air in the house at all. The diffusion is simply hindered not prevented by the presence of air, not prevented — the diffusion simply takes place more slowly than if air were not present.

But, the constant admission of cooled air, pouring down into the lower parts of the house, would help the this diffusion of the CO_2 by displacement, and by dilusion dilution; so that I should not we should hardly anticipate any serious consequences from the undue collection of CO_2 presence of carbonic dioxide in a tight house, so long as the air is constantly renewed by the introduction of fresh cool air into the house, and a free .

Still, supposing that there should be an undue collection of CO_2 in the lower parts of the house — , accumulating there to an injurious extent, the remedy is simple — an exit to the outside air ; sufficiently large to prevent the undue accumulation of CO_2 , and This could be adjustable so as to be made sufficiently small to prevent the cool air from escaping in sufficiently quantity to warm the house. Large quantity, without cooling the .

But, the deaths and prostrations due to the passage of the heat wave, are not due directly to the heat at all. The maximum 6 temperatures experienced during the present heat wave have not been high; only about 94° F. Sun strokes are almost practically unknown in Arizona and other arid places, where 94° F. is cool. The prostrations are due, not to the heat of the atmosphere, but to its humidity. A dry hot wave hurts no one, but a wave of humidity, even where the temperature is not high causes death and suffering.

The blood temperature in man is remarkable constant, F rom the Torid Zone to the Arctic regions, there is hardly any variation. If the blood temperature is elevated by even a single degree an abnormal condition exists, which we term fever.

Now, if a man were given the problem of preserving a fluid at a constant temperature, the whole year round, in hot and cold, it would really be a very difficult problem to solve. We would have to devise automatic means of for regulating the temperature, so that in cold weather we should apply heat to keep the liquid at the desired temperature, and when the weather was too warm we should cool it down.

But, what a problem it would be to do this if a man's life or health depended upon there being no substantial variation in the temperature of that liquid — a variation of even one degree either way meaning illness and suffering — and a variation of a very few degrees meaning death. I doubt whether the inventive genius of man would be equal to the solution of such a problem. But nature has solved it by providing means for the heating and cooling of the blood so as to keep it at substantially a constant temperature under 7 all ordinary conditions of ordinary heat environment.

Heat is produced in the lungs during the process of excidulating oxygenating the blood , . and during T he contraction of the muscles of the body, the tearing down The wasting of the tissues, during a muscular action — or from any cause — is also accompanied by an evolution of heat . So that, by muscular exertion, and by increased respiration, the blood can be warmed. So that Increased respiration muscular exertions or functional or within of may sort thus tends to increased the temperature of the body.

On the other hand, in the perspiratory system a means is provided for cooling the body — and consequently the blood-by the evaporation of water brought to the surface of the skin through the multitudinous pores that exist, and which are so constructed that they open when the temperature of the body is too high, allowing of the free passage of perspiration to the surface, and close when the body is too cold, thus obstructing the flow of fluid to the surface of the skin, and preventing the body from being further cooled by keeping the surface dry.

Now, when the body is too hot, th e pores of the skin open , and the liquid, which we call perspiration exudes, and the whole surface of the body becomes moist. But, this will not cool the body unless the liquid is evaporated. Water, in changing into a gas , absorbs heat, and nature takes advantage of this fact.

By the evaporation of the moisture on the surface of the skin the surface is cooled; without evaporation there is no cooling, so

Now, the rapidity of evaporation depends upon the dryness of the air. If there is little moisture in the air, so that the dew 8 dew- point temperature is very much below the dry - bulb temperature, evaporation will proceed rapidly, and the body tends to cool be cooled down to the dew-point temperature of the air. Should the dew point temperature be below the blood temperature, then, when the body has c ooled down a little way, the pores of the skin will close, the exudation of moisture will cease, there will be no substantial evaporation from the surface of the skin, and the cooling process will cease. Thus, — in such a case free prespiration will cool the body and preserve the proper blood temperature.

But, what will happen when great humidity exists. Let the hot atmosphere air be filled with aqueous vapor near nearly to the point of condensation, then, the body may be wet with perspiration, but evaporation will not take place. The person will perspire and not be cool ed . Under such circumstances t he blood temperature will may rise, and a very slight rise will produce prostration and or death.

Hence, the enemy is not heat, but moisture. I have no doubt that — if we could take a census of the deaths and prostrations during the present heat period and compare them with the general population, so as to get proportionate numbers, and then plot the results upon a map, joining together by a line those places that have equal death rates due to what is called heat prostration; and then plot upon the same map a series of isothermal lines, I have no doubt that we should find that T he highest death rates do NOT occur at the hottest places, — indeed, I should anticipate that the two series 9 of lines would have little relation to one another.

On the other hand, should we note the dew point temperatures and calculate the relative humidity of the air at each place, and then connect together by a line those places that have the same percentage of humidity, I have no doubt that we would find that this system of lines would have the closest possible relation with the death rate. Deaths and prostrations would be found occur in places having a high humidity, even though the temperatures may be comparatively low, and the while the death rate would be is slight in dry places where the temperature might be is high.

Upon thinking the subject over, it is obvious to me that T he amount of aqueous vapor in the air has more to do with deaths and prostrations than the elevation of temperature.

In artificial buildings, it should certainly be possible for man to control the internal climate of his residence. It should be possible for him to cool, or dry, the internal air of his house to any extent. It is more important, I think, — as a safe guard against heat prostration — that the house atmosphere should be dry than that it should be cool, so as to allow perspiration on the body to evaporate, and thus cool the blood. Cooling the internal air of the house alone will not do, for we thereby increase the humidy of the contained air — indeed, were we to cool the air sufficiently 10 moisture would actually be deposited on upon the walls and elsewhere. We would produce dampness as well as coolness. — damp, cool Cool but air would be the alternative for heat prostration — one discomfort for another. It is obvious that we need dryness as well as coolness.

The people of hot countries agitate the internal air of a house by means of a punkah; puncas, or fans, and we also adopt the same method by employing rotatory fans — electric fans, &c.

This method produces a cooling effect by promoting the evaporation o f the moisture on the surface of the skin. Wind, A or a A ride upon the electric cars, cools upon the same principle. But, here again the cooling effect depends upon the amount of moisture in the air. In a dry climate the effect would would be great; but where great humidity exists the effect would be it be small. With saturated air it would be nil .

Electric fans, puncas punkahs , or fans of any sort , depend for their effect upon the dryness of the air. When, therefore, we consider what we should do in order to render our houses comfortable during hot waves like the present, it is of the first consequence that we should dry the air.

The character of our clothing is also is of importance. It should be of such a character as to promote the evaporation of the moisture from the skin. I have no doubt that a waterproof coat might's A Macintosh or waterproof might actually, be be fatal by interfering with this. in such weather as this. The clothing should be porous so as to absorve the moisture and bring it to the outer surface of 11 the cloth ing es , where it will come into contact with the dry air and so as to be evaporated. Thus the clothing will be cooled, and , through the clothing , the skin. Of course, it would be still better to have no clothing at all, but this our civilization would not permit.

To sum of—

Now, let me sum up these ideas and see where we stand. —

During oppressively hot weather of the kind we have been experiencing it is advisable to fill our houses with cool, dry air, and to agitate the air so as to promote the evaporation of moisture from the skin. It would also be advisable to change the air constantly. There should be free exit into the atmosphere above and escape below should be obstructed or prevented. The open tumbler is the ideal condition with a controlable exit of slight capacity below.

Now, what means have we for filling our houses with dry, cool air. As the outside air available is neither dry nor cool, it is obvious that we must have a reservoir somewhere into which we can the warm, damp air take air, cool it and dry it, and then deliver it into the house. By compressing the air in a chamber it becomes heated, to a greater extent than its surroundings , but if we leave it alone it will gradually cool down to the same temperature as its environment s . But, in the process of the cooling down the humidity of the contained air in increased and if the compression is sufficient it will be supersaturated and deposit some of its mois utre ure in the form of water, which can be collected 12 and removed.

We have then in this tank a certain amount of air under great pressure, and having the same temperature as the outside air, but containing a less amount of aqueous vapor than an equal bulk of outside air.

Now, if we allow this compressed air to escape into a larger tank under ordinary atmospheric pressure, the air will be cooled by the expansion, so that the large tank will contain air at ordinary atmospheric pressure cooler than the surrounding air. In the process of time it will warm up to the temperature of its surroundings so that ultimately we will have a tank of air at ordinary atmospheric pressure and of the same temperature as the surrounding air, but with less moisture in it. It will be drier.

In the above case we started by cooling the compressed air down only to the temperature of the surrounding air, but in practice it is easy to cool it down very far below that point. Ordinary water from a main is considerably below the temperature of the sir during a hot wave, and a water jacket therefore, round a compressed air tank would cool the compressed air to a greater extent than before assumed, and rob it of a considerably greater proportion of its moisture, which would condense as water and be removed.

By compression and cooling , the water would be squeezed out of the air like moisture out of a sponge. The greater the compression and the greater the amount of cooling in the compressed state, the drier would the air prove to be in its expanded condition. By means 13 of amonia machines such as those employed in the artificial manufacture of ice, nearly all the moisture can be removed from the air: And, if the pressure and coolness are sufficient to liquify the air we have produced a liquid free from water altogether, at least practically so. The water has been frozen out of the air, so that if liquid air be allowed to evaporate into a chamber at ordinary atmospheric pressure, it will not only produce a tank full of very cold air, at atmospheric pressure, but the air will be almost absolutely dry: Practically it would contain no aqueous vapor at all.

If such air were admitted into the interior of a house, it would, on account of its coldness be specifically heavier at the atmospheric pressure than the warm air of the house, and so would displace it. The cool air would descend to the lower part of the house, warm air would escape above. If there was no outlet below , or only an insufficient outlet, you might fill up the house with this cool air as you might fill a tumbler with ice water. This air would not only be cool, it would be dry, and all the conditions would exist to make the house comfortable and habitable in hot weather.

A mere tank of liquid air in the upper part of the house would by its evaporation cool the lower part of the house, or the whole of the house below it, if there is no t outlet below through which it can escape.

There is a great future for liquid air in this application if it can be produced cheaply. The only difficulty that I foresee is arises from the fact that nitrogen and oxygen have different temperatures of evaporation, so that the first products of the evaporation of liquid air contain nitrogen in excess; whereas the last products are composed almost exclusively of oxygen. This might interfere with the use of liquid air for the purpose intended, but no such objection could be urged against air merely compressed and not liquified. The cost of the necessary plant, however, would probably be prohibitory to individuals, excepting in the case of the wealthy, but, a company, supplied with the necessary plant, and having a central office in a city, could very cheaply supply houses with cool, compressed air through a system of pipes, in the same way that water and gas are now supplied.

Under such circumstances, it would only be necessary to turn a cock, or faucet, to admit the compressed air into the house. Then, if the house is tight below and open above, the whole house will gradually fill up with cooled dry air, which will constantly be renewed as long as the faucet is open. This seems to me to be the most practical solution of the problem.

But two things are requisite: —

1st. The formation of a city plant, like that used in Popp's System of compressed air in Paris, France, and

2nd. A modification of the houses receiving the compressed air preventing or limiting escape of air below, and permitting free escape above.

I feel pretty sure that with a large plant, supplying compressed air to multitudinous houses, the cost would be so slight that air could be supplied to tenement houses and factories, and 15 relieve suffering and prevent death s in a wholesale manner.

The stati cs stics of death and prostration are sufficiently great to show that this question is one of immediate and pressing importance.